



TeV & X-ray emission from the binary HESSJ0632+057

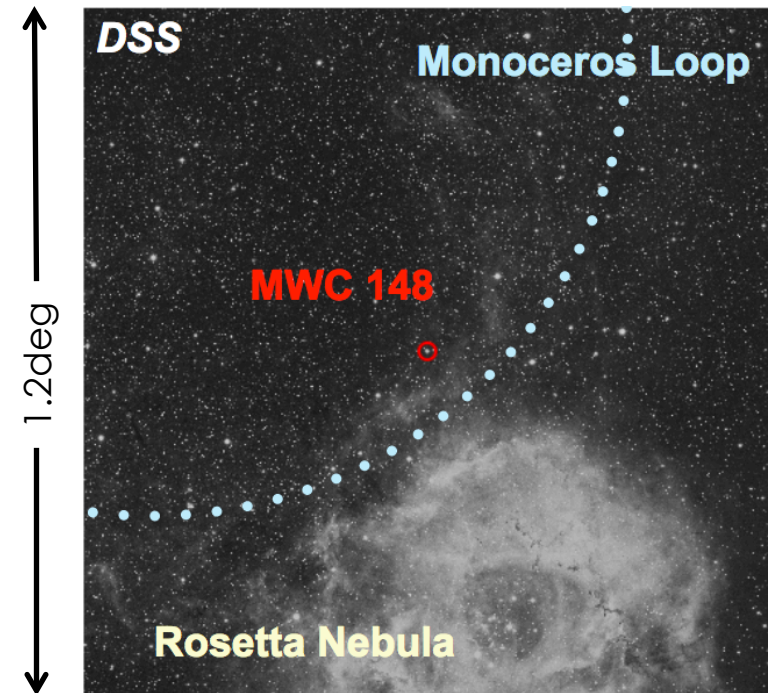
Daniela Hadasch, O.Blanch, A.López-Oramas, N.Komin, M.Lundy, G.Maier, D.Malyshev, J.Moepi, S.Ohm, G.Pühlhofer, R.Prado, S.Schlenstedt, D.F.Torres, B.Zitzer for the H.E.S.S., MAGIC, and VERITAS Collaborations

Overview

- Introduction & history of HESSJ0632+057
- Updated orbital solutions from optical observations
- Observations in TeV
- Period search in TeV & X-rays
- Spectral behavior along the orbit
 - TeV & X-ray
- Orbital coverage
 - TeV & X-ray
- Summary

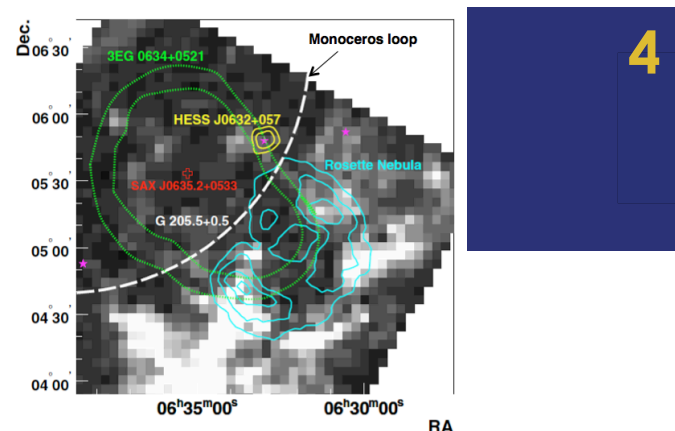
Introduction

- MWC 148: B0pe star
 - $M=16M_{\odot}$, $R = 6.6 R_{\odot}$, $T = 30 \times 10^5 \text{ K}$
- Distance: 1.1-1.7 kpc
- Orbital period from Swift XRT data
~315-320 days
- Nature of compact object in binary system unknown
 - Despite deep observation campaigns: no pulsation found neither in radio nor in X-rays

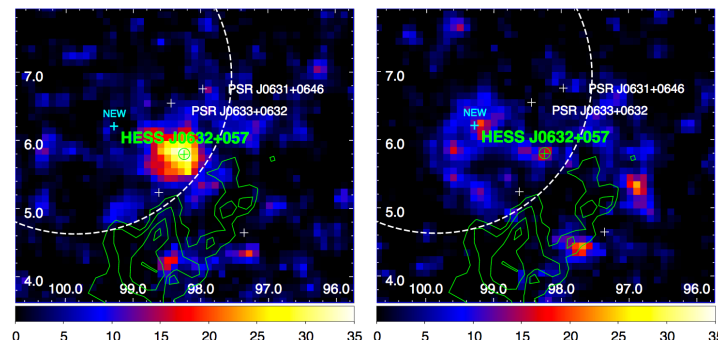
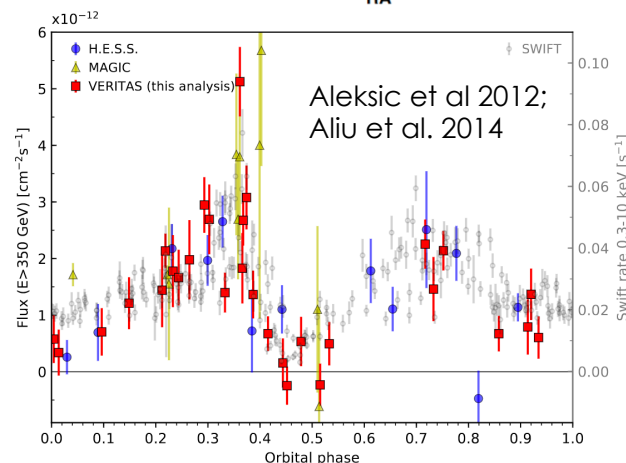


History

- **Discovered** as point-like VHE γ -ray source (H.E.S.S.) in 2004
 - Visible from Northern + Southern hemisphere
- Evidence for **variability** through VERITAS non-detection in 2009
- Discovery of **orbital period** of 320 day through Swift XRT data in 2011
- **Detections** by H.E.S.S., MAGIC and VERITAS after X-ray outburst
- Detection in **GeV** after 9 years of Fermi data



4



Li et al. 2017

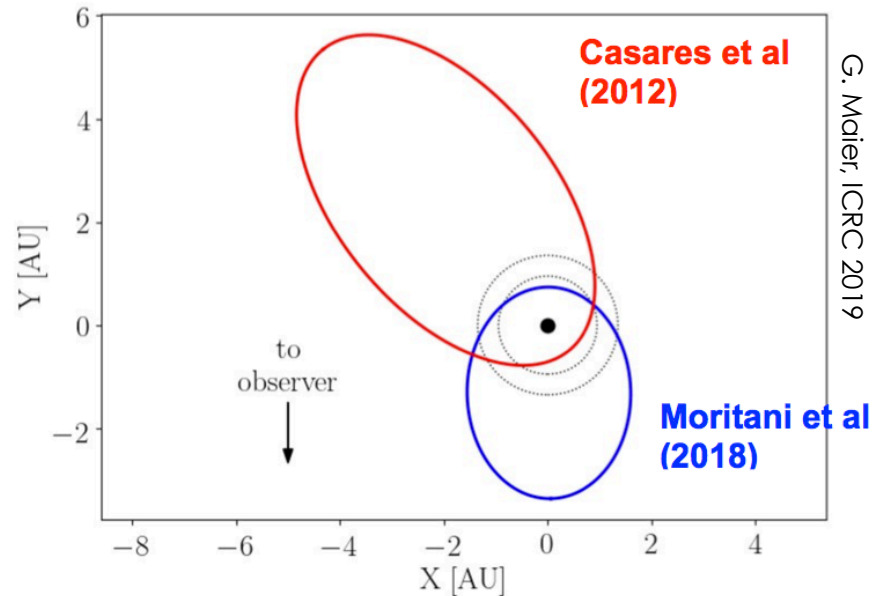
Orbital solution

- New orbital solution through H α measurements (Moritani et al 2018)
 - Measured radial velocity of the H α emission line
 - Resulting period: 308^{+26}_{-23} d
- Through X-ray measurements (Moritani et al 2018)
 - Resulting period: 313^{+11}_{-8} d
- Periods derived by Moritani consistent with previous measurements

Parameter	Casares et al. (2012)	H α	X-ray	
Period P_{orb} [d]	321 [†]	308 [‡]	313 [§]	→ consistent
T_{peri} [d]	2455167.907	2455076 \pm 10	2455065 \pm 11	
Periastron ϕ_{peri}^*	0.967	0.709	0.663	→ different
Eccentricity e	0.83 \pm 0.08	0.62 \pm 0.16	0.64 \pm 0.29	→ smaller
ω [°]	129 \pm 17	249 \pm 26	271 \pm 29	
K_1 [km s ⁻¹]	22.0 \pm 5.7	6 \pm 1	5 \pm 2	
γ [km s ⁻¹]	48.3 \pm 8.9	36.9 \pm 0.8	36.7 \pm 0.9	
$a_1 \sin i$ [au]	0.362 \pm 0.261	0.136 \pm 0.029	0.120 \pm 0.029	
Mass function $f [M_{\odot}]$	0.06 ^{+0.15} _{-0.05}	0.0035 \pm 0.0022	0.0024 \pm 0.0017	→ smaller

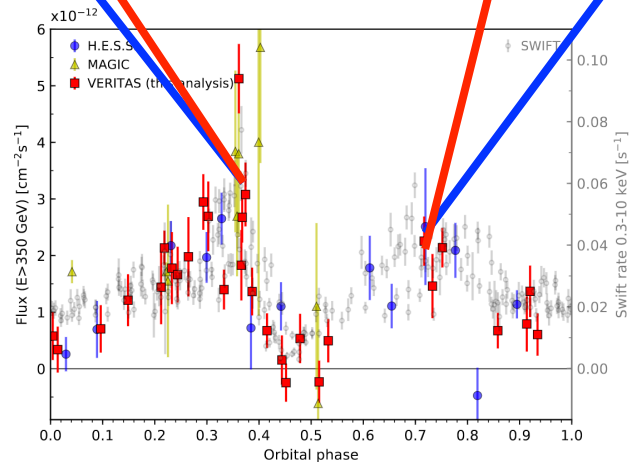
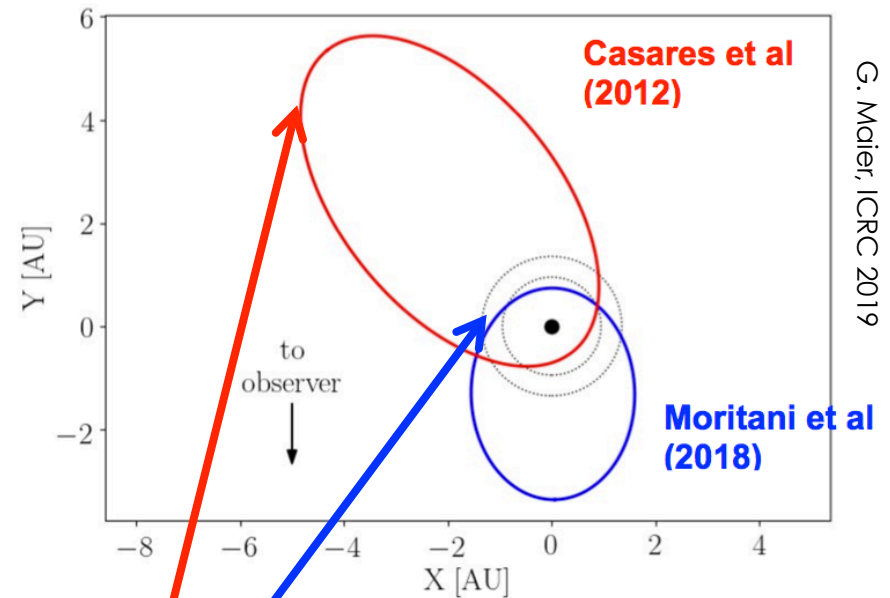
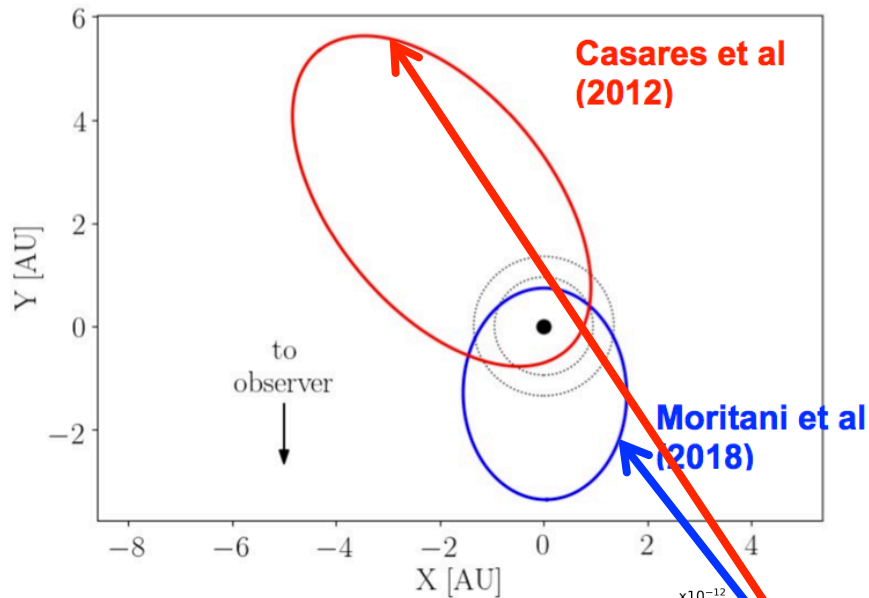
(Moritani et al 2018)

Orbital solution



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Orbital solution

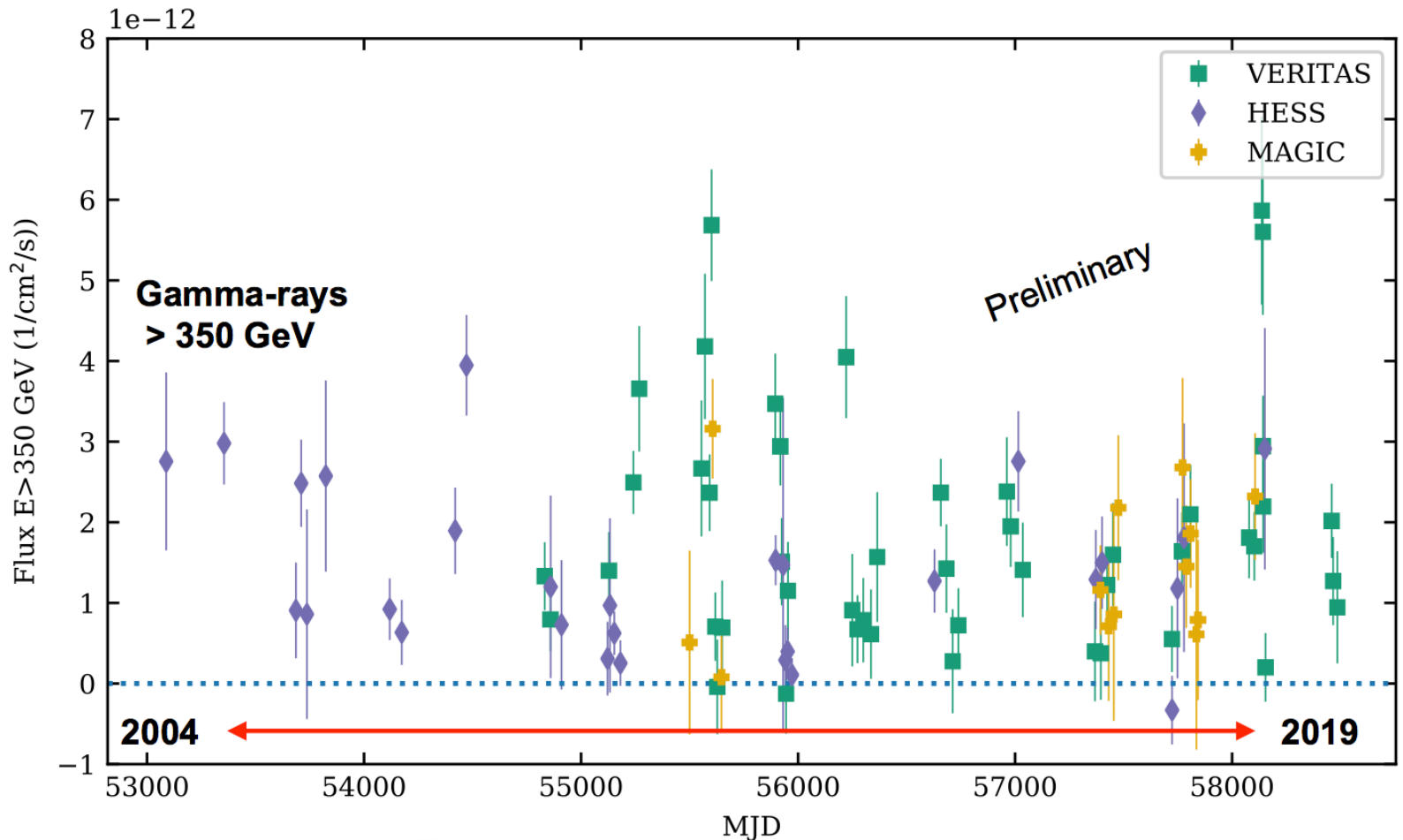


Overall VHE Observations

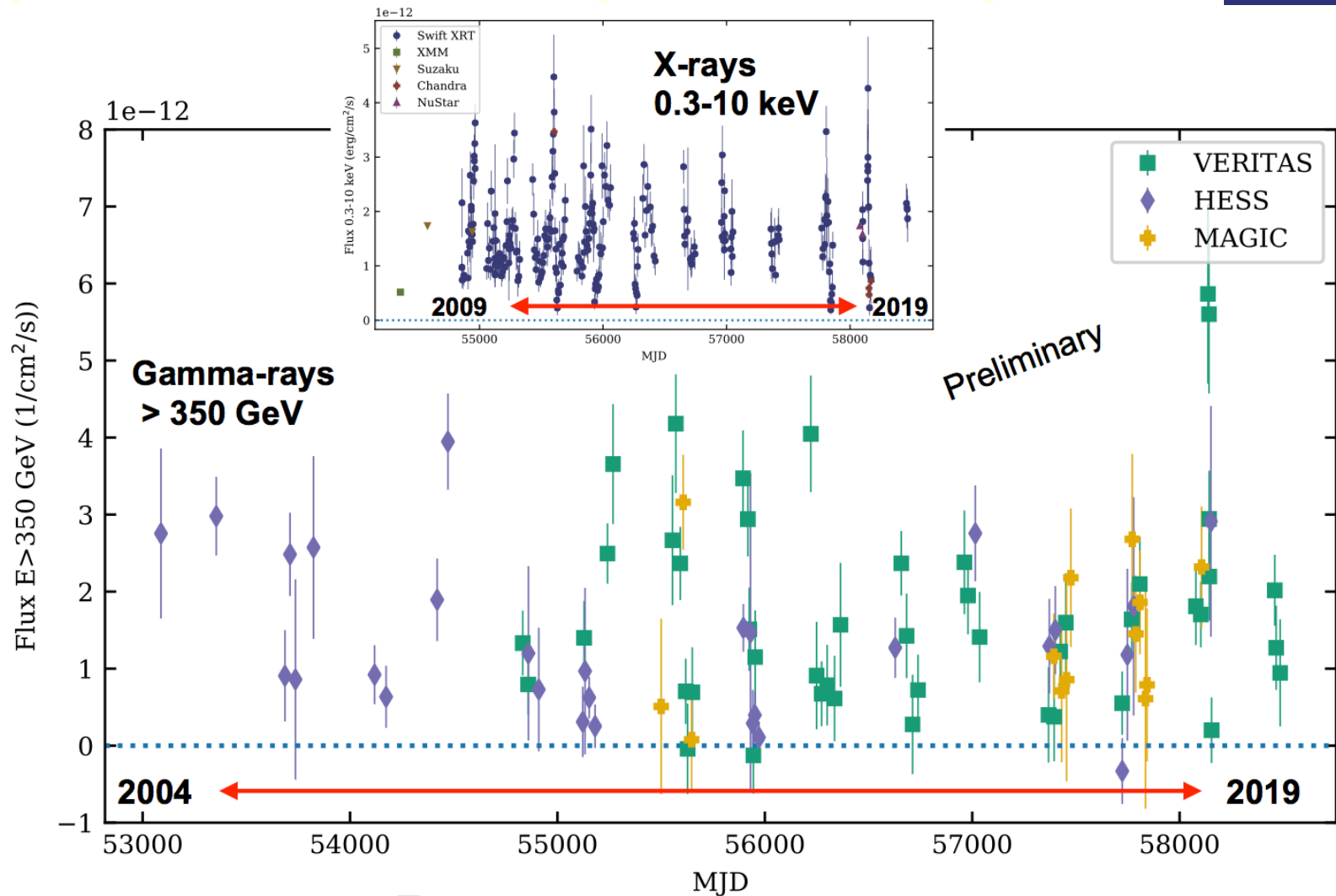
- Large data set of 440 h obtained from 2004-2019
- H.E.S.S.
 - CT1-4: 99 h
 - CT1-5: 15 h
 - CT5: 18 h
- MAGIC
 - 48 h
- VERITAS
 - pre-T1 move: 20 h
 - post-T1 move: 117 h
 - post-camera upgrade: 112 h
 - bright moon (red. HV): 11 h



Long-term lightcurve over 15 years TeV



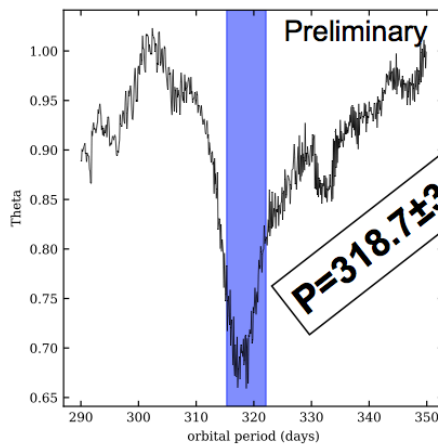
Long-term lightcurve over 15 years TeV & 10 years X-rays



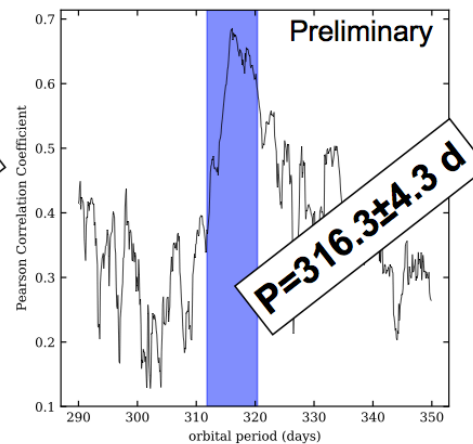
Orbital period search with gamma-rays

- Orbital period determined for the first time from gamma-ray data
 - Methods applied using Monte Carlo-generated light curve

**Phase Dispersion
Minimisation
Gamma-rays > 350 GeV**



**Pearson's Correlation
Coefficient
Gamma-rays > 350 GeV**

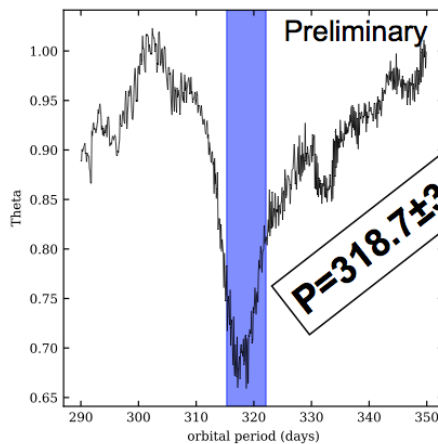


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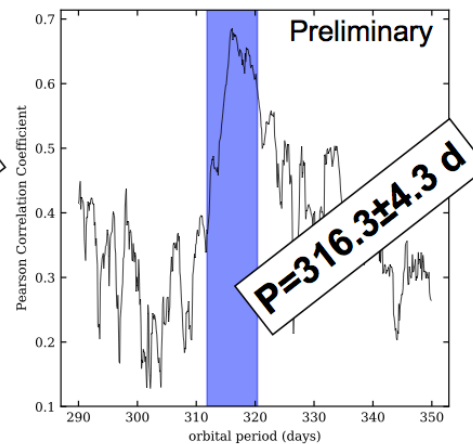
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 - Methods applied using Monte Carlo-generated light curve
- Updated X-ray analysis using all available XRT data
 - (MJD 54857–58168)

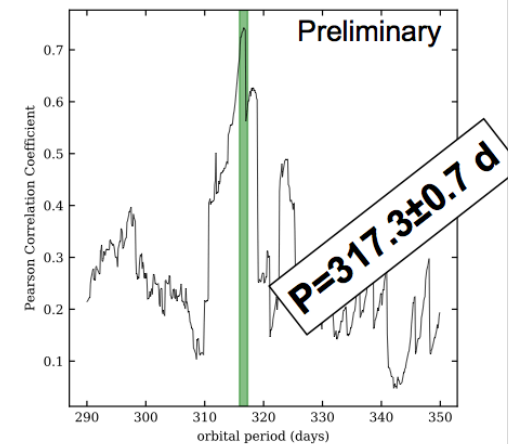
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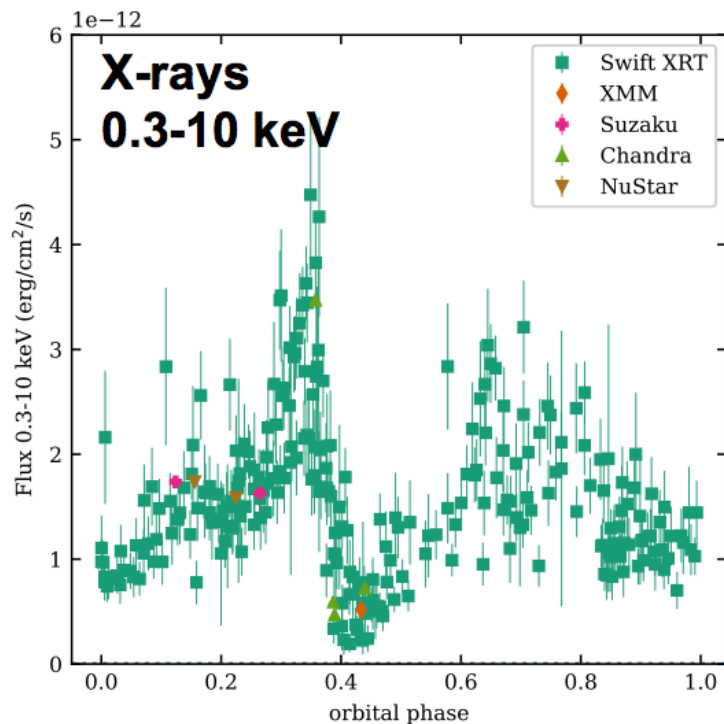
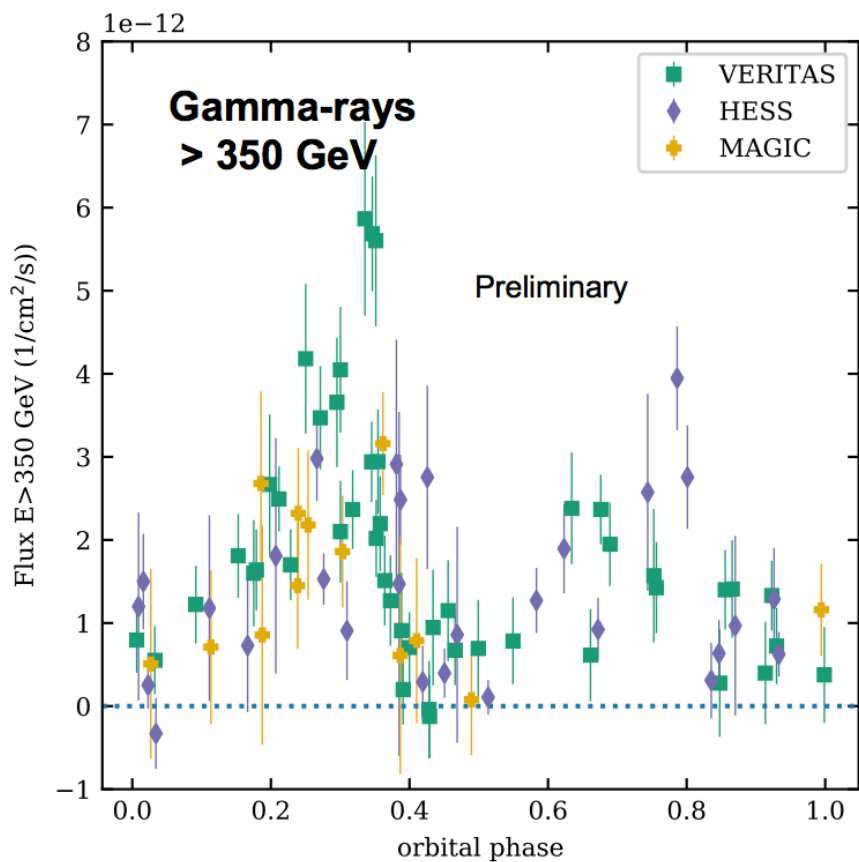
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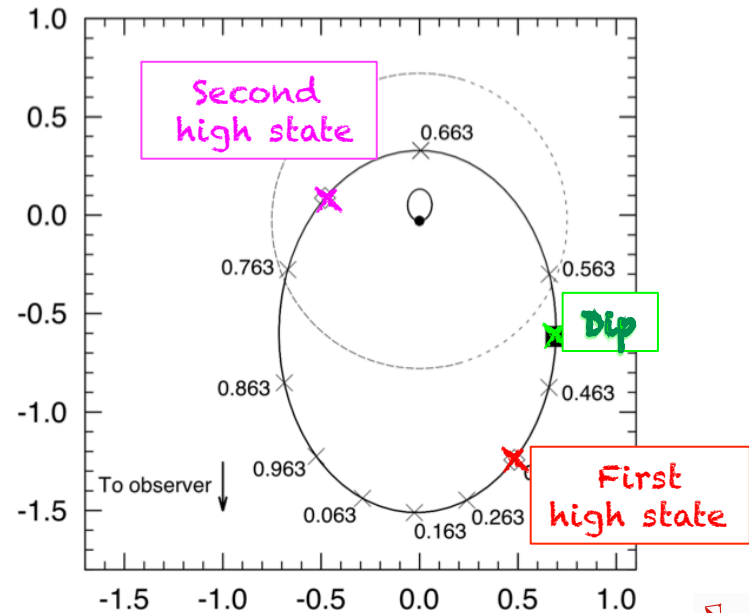
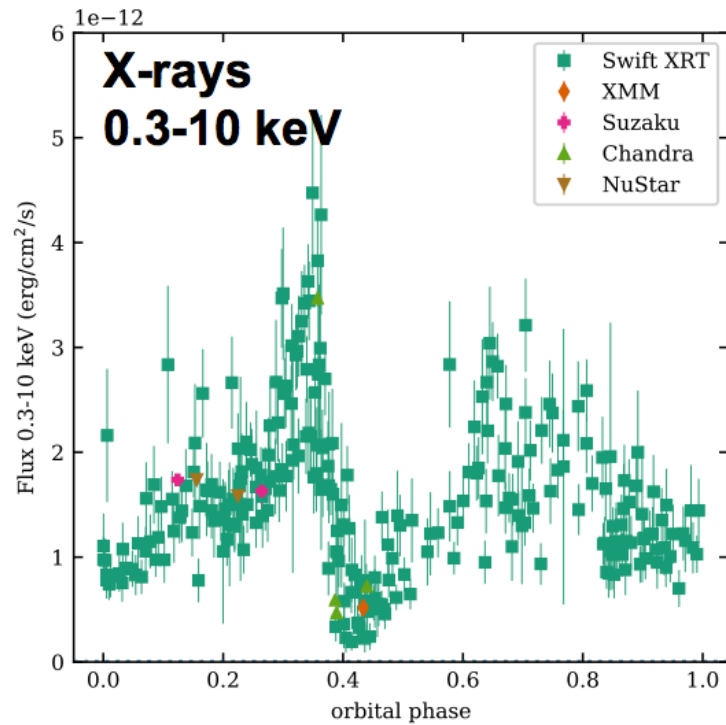
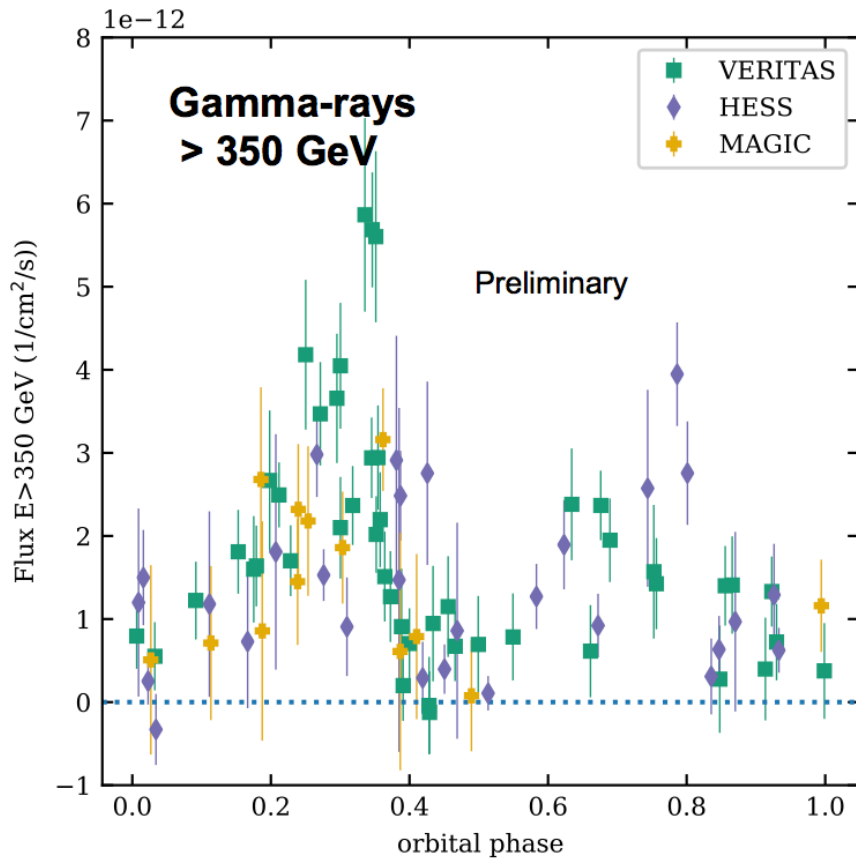
**Pearson's Correlation
Coefficient
Swift XRT 0.3-10 keV**



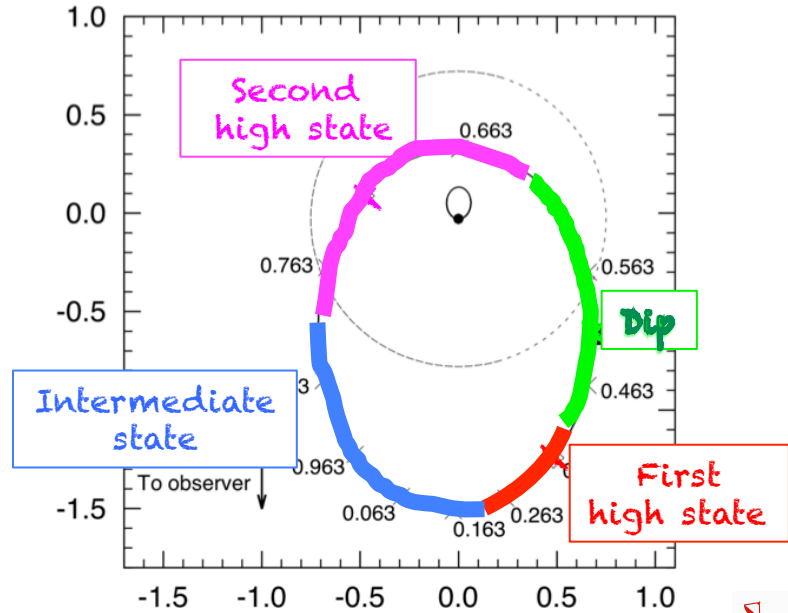
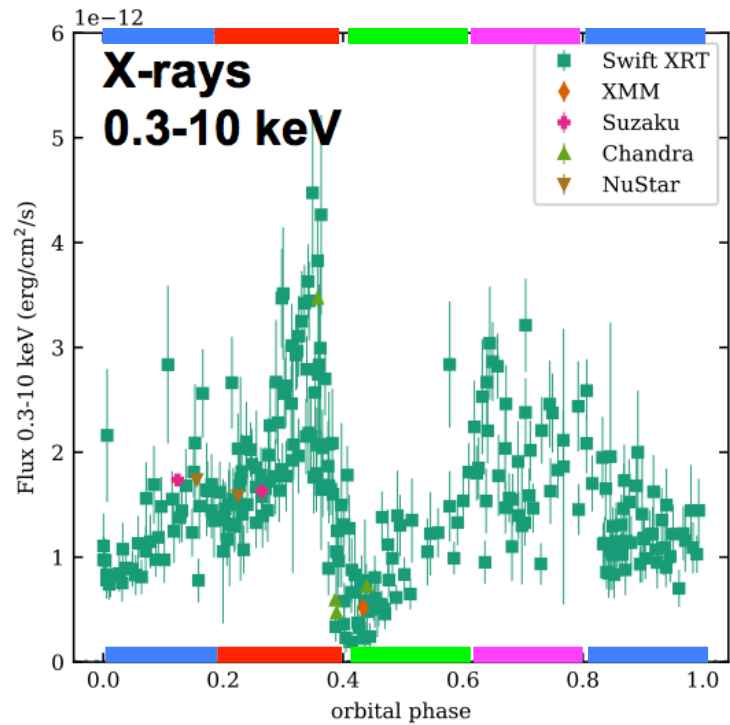
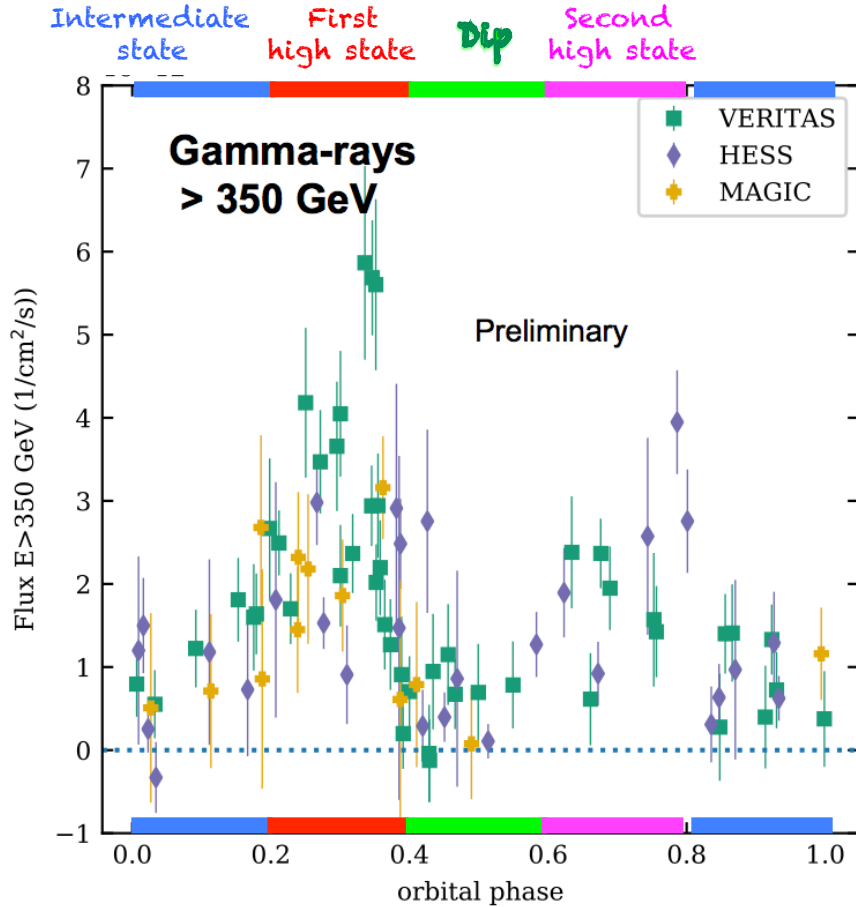
Folded lightcurve



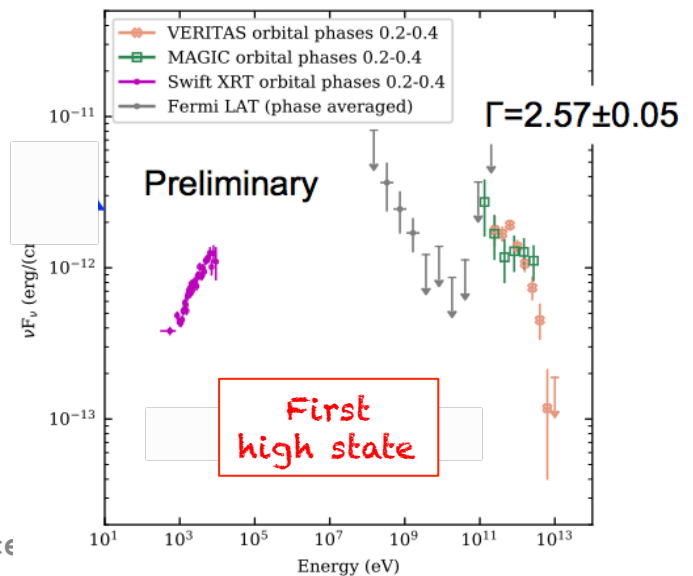
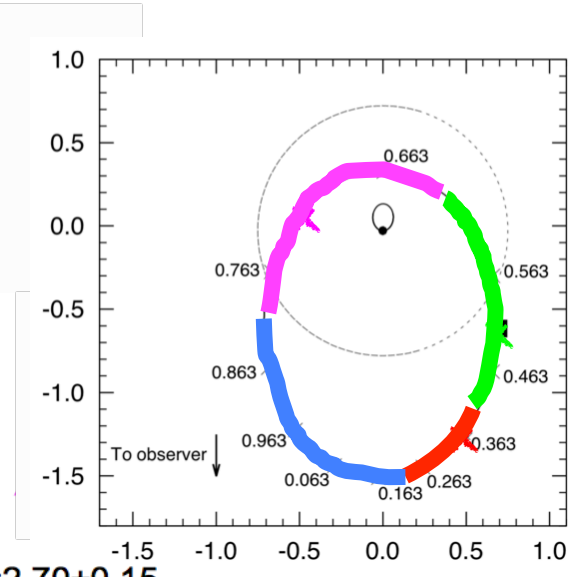
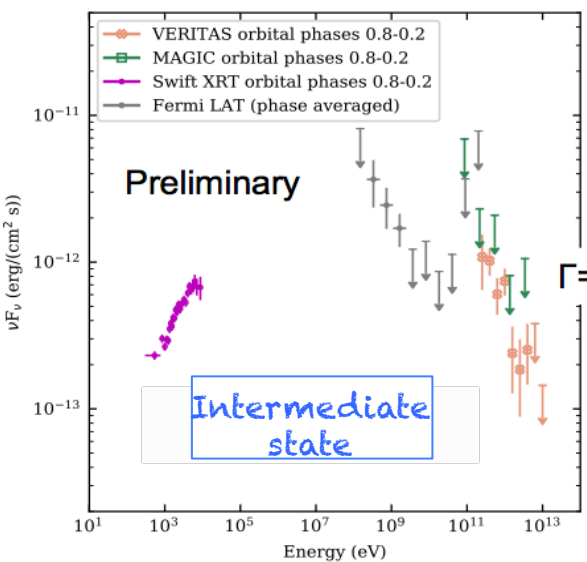
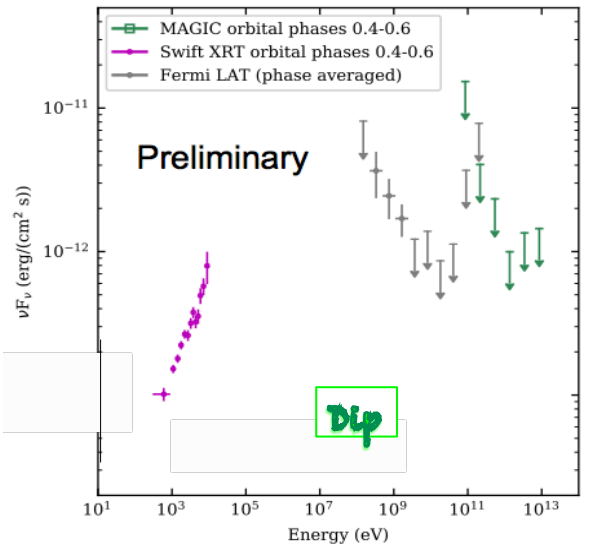
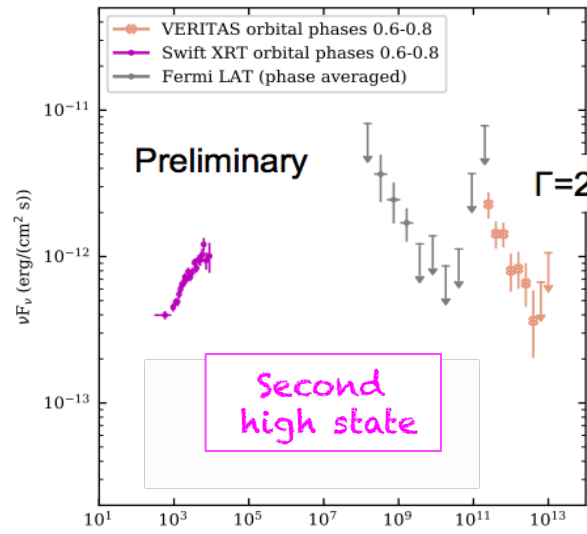
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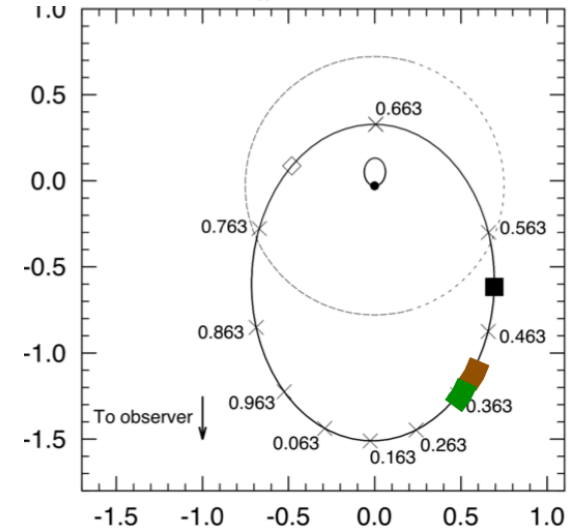
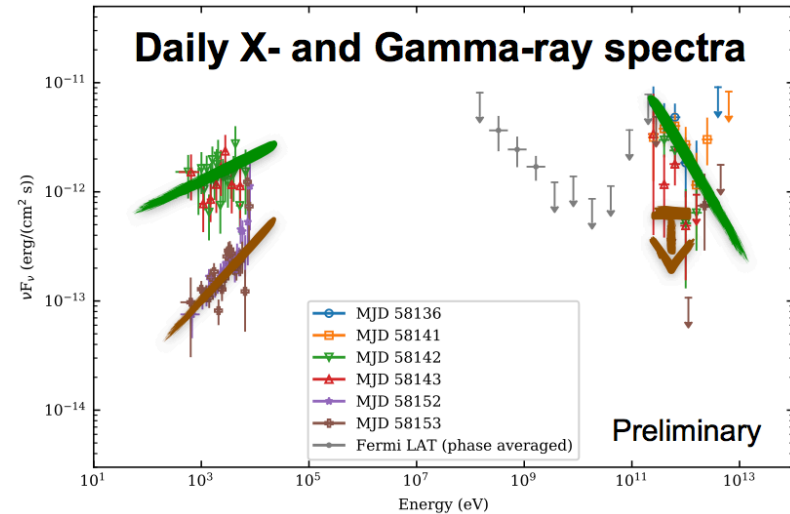
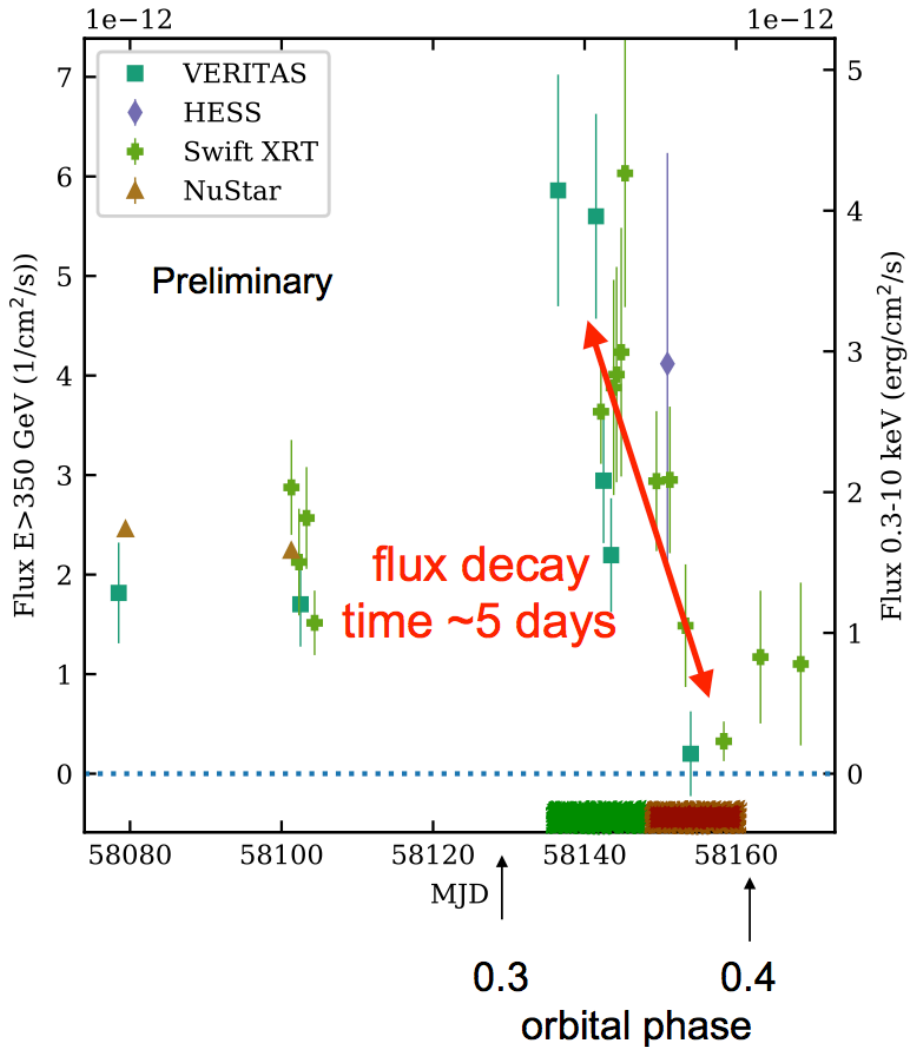
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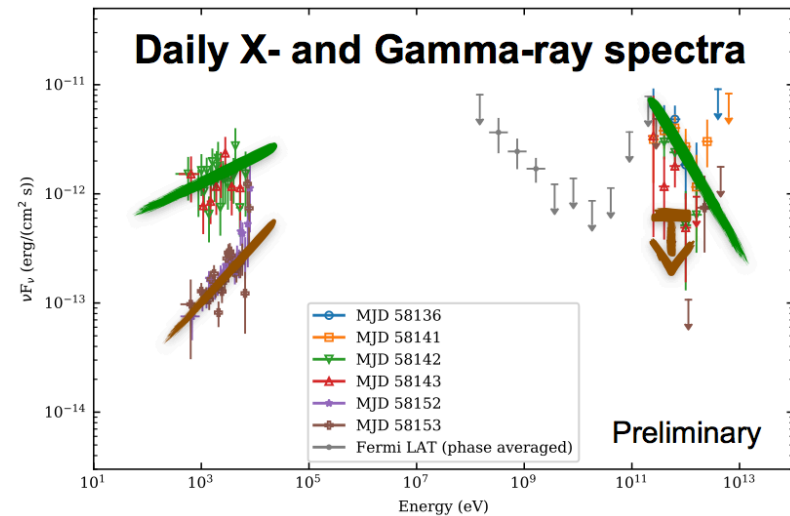
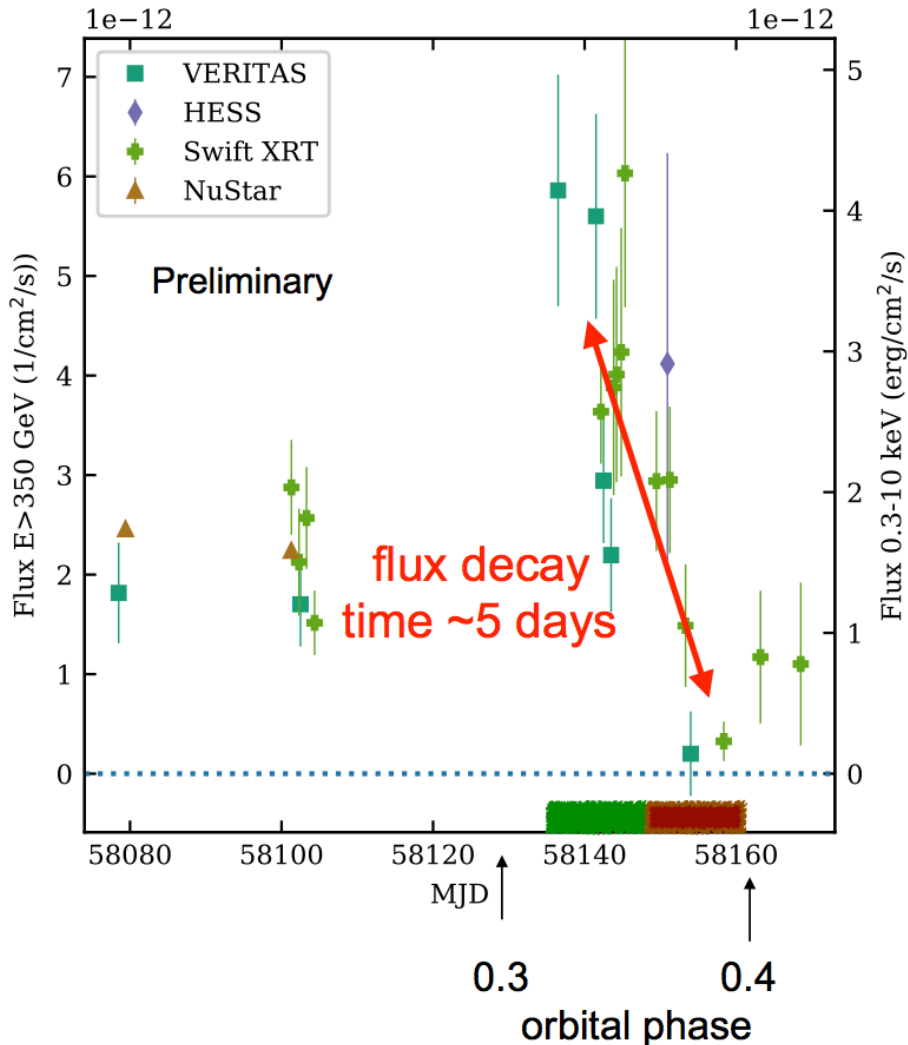
Spectra during different orbital phases



Bright state in 2018

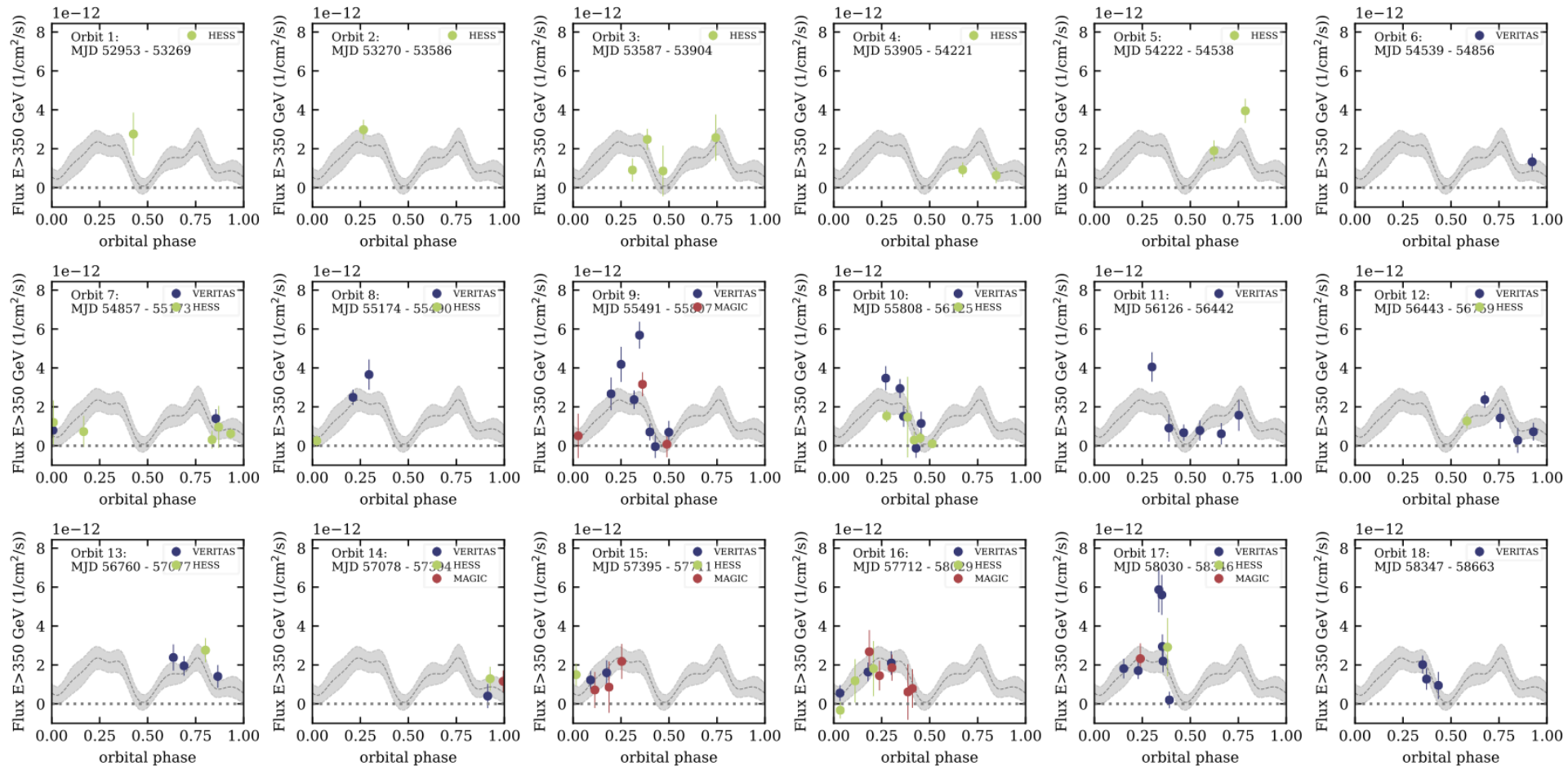


Bright state in 2018



H-alpha emission increased →
structural changes in outer parts
of the **circumstellar disc**, where
the H-alpha emission is formed
(Zamanov+, ATel# 11233)

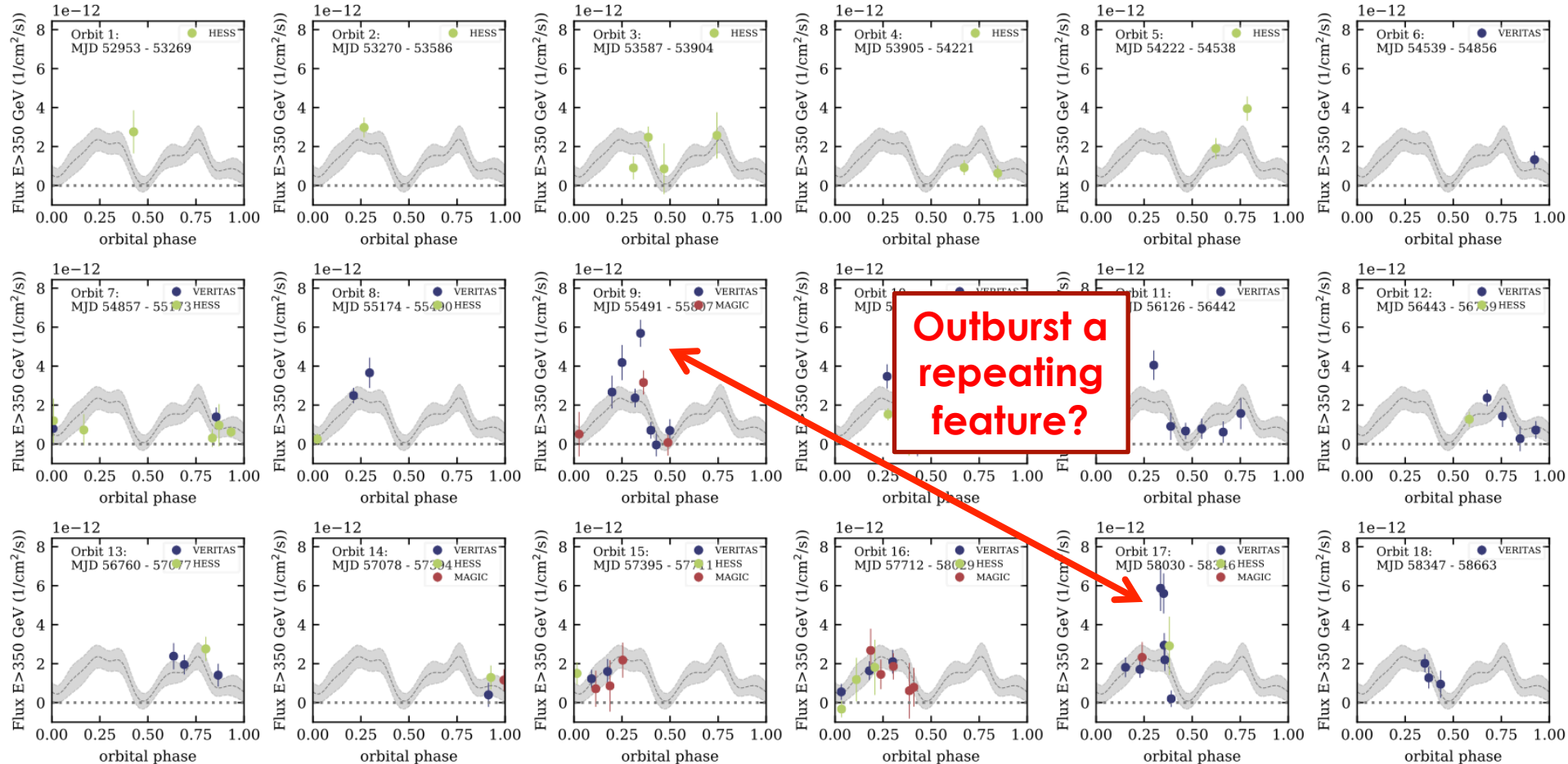
TeV coverage per orbit – 18 orbits



Assuming an orbital period of 317.3 days
 Grey band: average Gamma-ray light curve
 (68% uncertainty band)

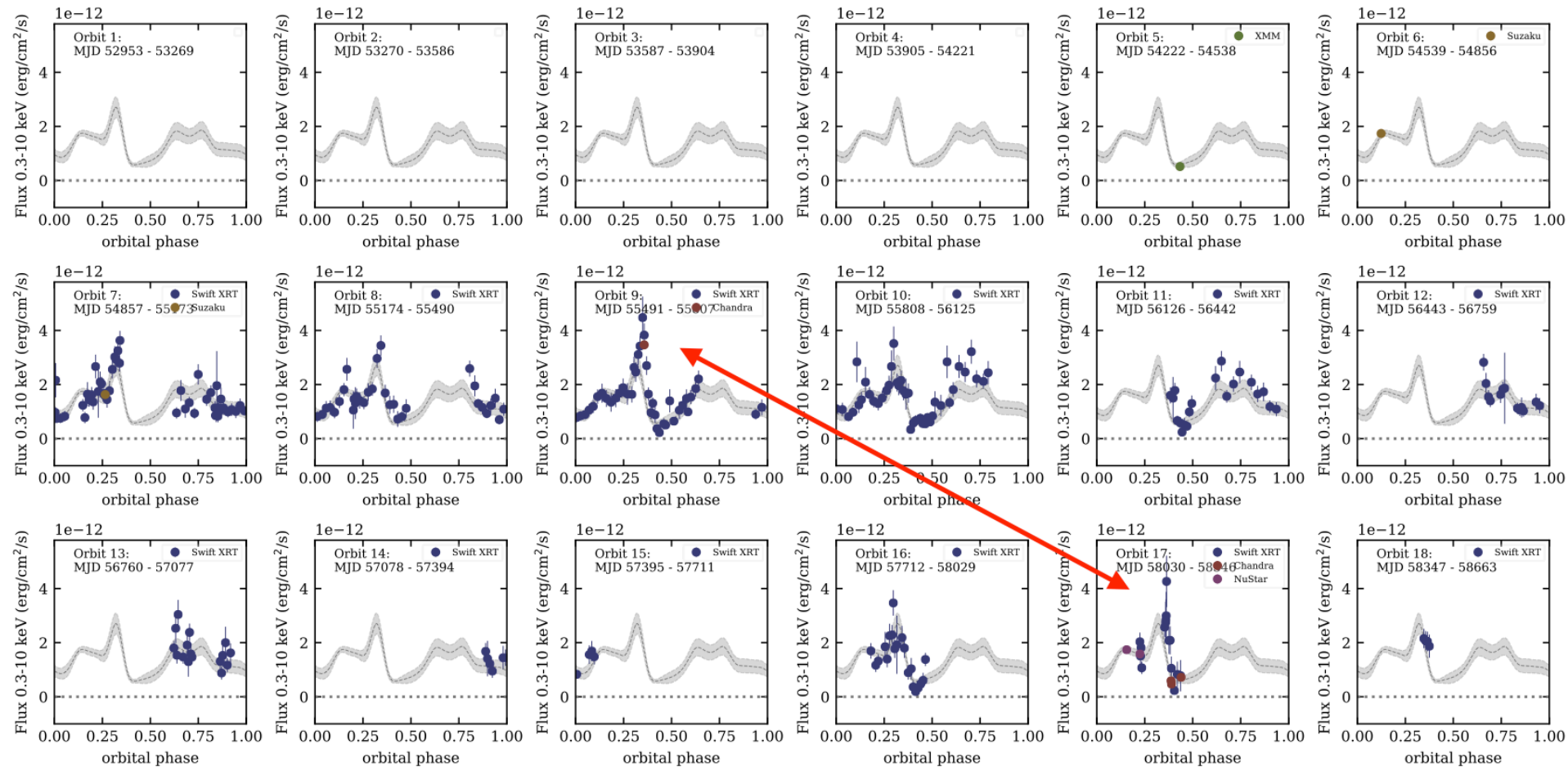
TeV coverage per orbit – 18 orbits

20



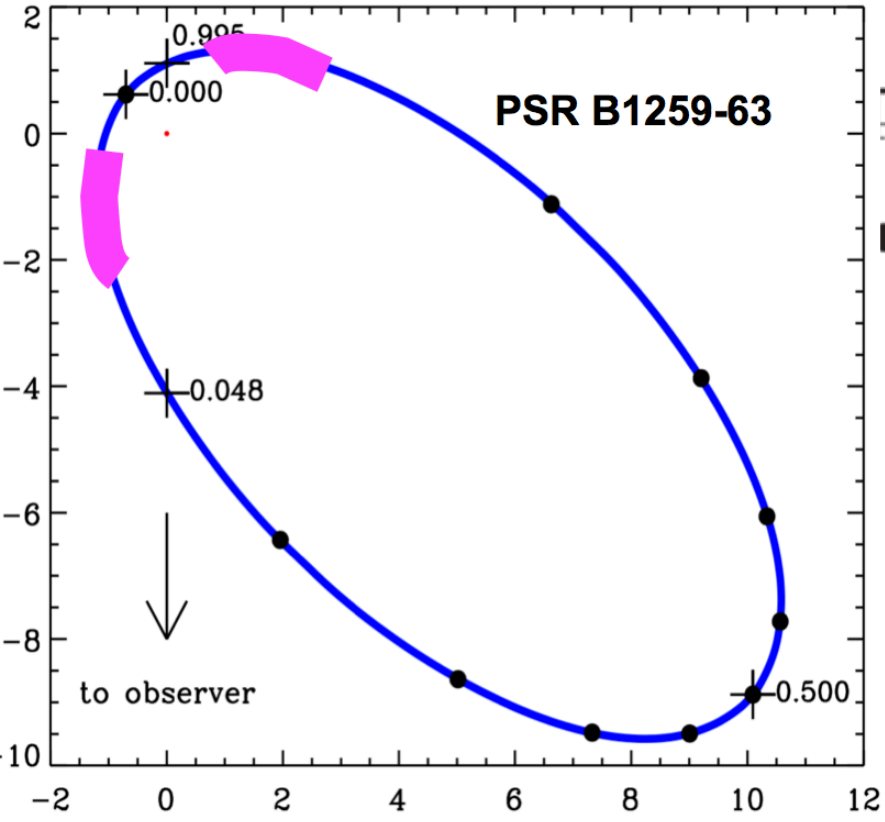
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X-ray coverage per orbit

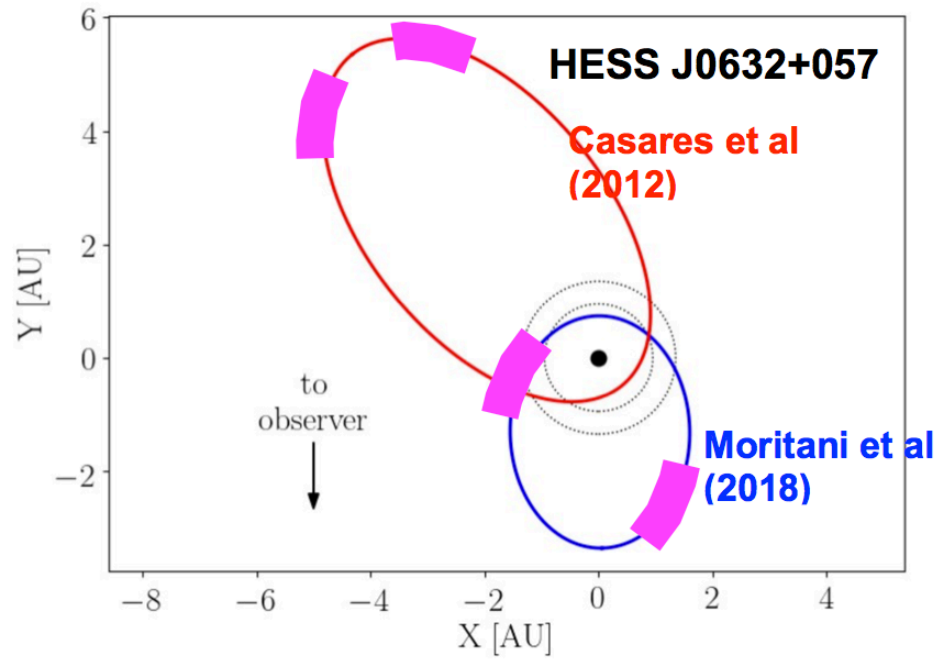
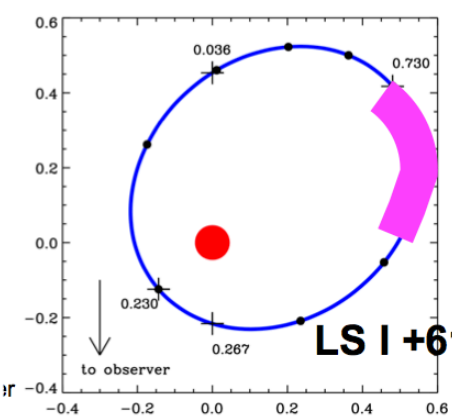
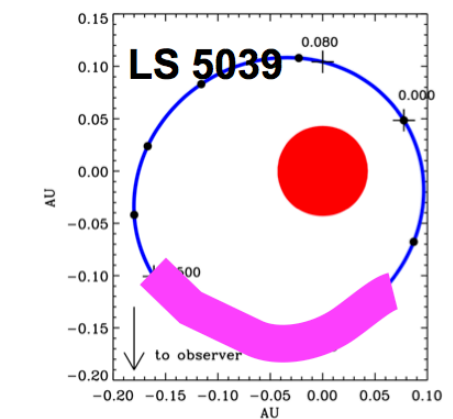
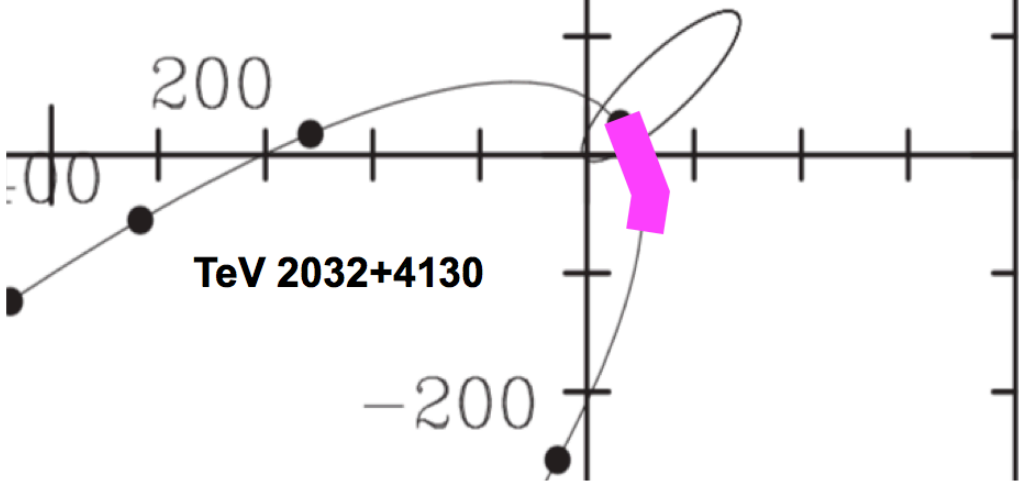


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Common picture?



very rough illustration!



(ignoring large uncertainties in orbital solutions)

orbital plots from Dubus 2013, Ho et al 2018

Summary

- 15 years of observations of HESS J0632+057 with H.E.S.S., MAGIC, and VERITAS
- Orbital period derived through X-ray and gamma-ray measurements
 - 317 +/- 0.7 days /X-ray
- Lightcurves at X- and gamma-ray energies show similar behavior
- Repeating outburst hint for super-orbital variation?
- Publication with detailed spectral analysis (phase averaged and in short time bins) in preparation

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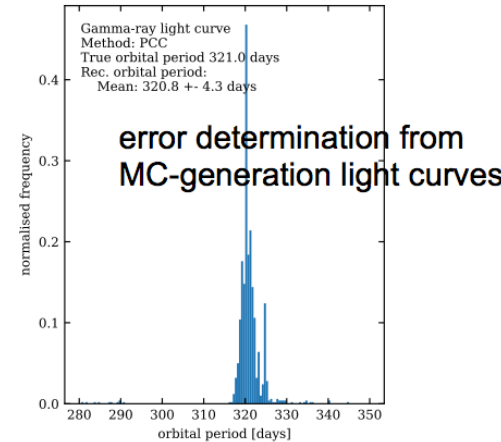
THANK YOU!

BACKUP

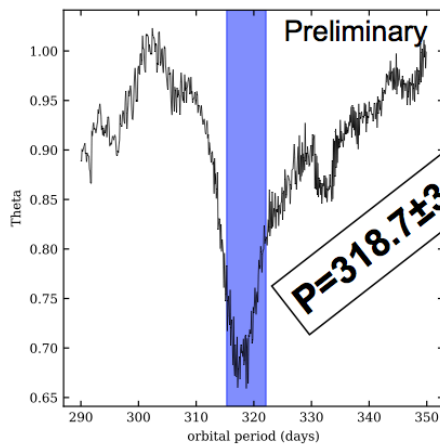


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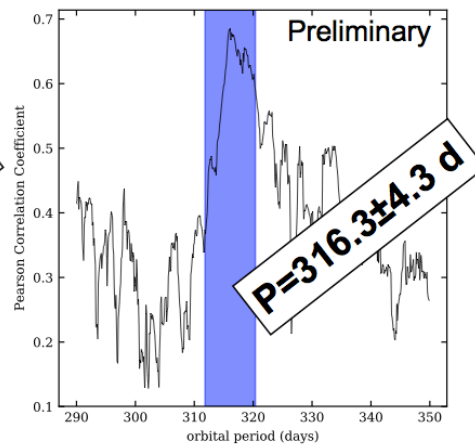
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